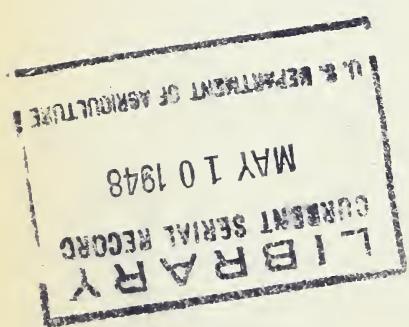


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Yellows-Resistant Varieties of Cabbage in the Early and Midseason Roundhead Groups

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INTRODUCTION

Yellows is an important disease in many cabbage-growing regions, especially in the Northern States. The disease organism (*Fusarium oxysporum* f. *conglutinans* (Wr.) Snyder and Hansen) persists indefinitely in infested soil, and the only feasible means of control is the use of yellows-resistant varieties (7).⁴ Beginning in 1910, a continuous breeding program for the development of resistant varieties suited to various growing and marketing needs has been carried on cooperatively by the Wisconsin Agricultural Experiment Station and the United States Department of Agriculture.

Since 1910 several new resistant varieties have been developed in the early roundhead group represented by the older varieties Copenhagen Market and Golden Acre and in the midseason roundhead group represented by the older variety Glory of Enkhuizen. The last-named

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⁴ Italic numbers in parentheses refer to Literature Cited, p. 20.

variety was introduced to the American trade in 1902 (2). Copenhagen Market was introduced in 1909 (2); since then various strains have been distributed. Some of these strains are larger and later than the original introduction. Golden Acre was introduced somewhat later as an early strain of Copenhagen Market, and the name "Golden Acre" as now generally used applies to those early strains which resemble closely the original Copenhagen Market stock.

The first yellows-resistant varieties selected from these groups were introduced in 1927 by the United States Department of Agriculture and the Wisconsin Agricultural Experiment Station (9). These were Marion Market and Globe. Marion Market was a selection from Copenhagen Market, but it conformed in type and season to the later, larger strains of Copenhagen Market. Globe, a selection from Glory of Enkhuizen, conformed to it rather closely in type and was only slightly later in season. An earlier variety, selected from Copenhagen Market, was introduced in 1935 under the name "Racine Market" (11). The following year Ferry-Morse Seed Co., Detroit, Mich., introduced under the name "Resistant Detroit" a resistant variety which conformed rather closely to the Golden Acre type. In 1940 the United States Department of Agriculture and the Wisconsin Agricultural Experiment Station introduced a still earlier resistant Golden Acre type under the name "Wisconsin Golden Acre" (12). Thus there are now available five yellows-resistant varieties in the early and midseason roundhead groups; these range in season from that slightly earlier than the standard Golden Acre type to that slightly later than Glory of Enkhuizen.

During the course of the breeding program it was shown that two types of inherited resistance to yellows occur. One type, commonly referred to as type B, is inherited as a quantitative character and is controlled by an undetermined number of genes (1, 7). The other type, commonly referred to as type A, is inherited as a qualitative character and is controlled by a single gene, *R*, which is completely dominant to the gene for susceptibility, *r* (6, 7). Type B resistance is suppressed by high temperature, by low nutrient concentration, and by nutrients low in potassium, whereas type A resistance is stable over a wide range of temperature and host nutrition (8, 10). Type A resistance is, therefore, the more satisfactory. It has been incorporated in each of the five yellows-resistant varieties described in this circular. Tests carried on over a period of years have shown that most commercial stocks of these varieties contain a high percentage of individuals with type A resistance. In order to maintain this high percentage of resistance in a given stock (7), however, constant care must be exercised in maintaining the stock seed and isolating the seed fields at least 160 rods from fields of susceptible varieties.

The purpose of this circular is to bring together pertinent data from trials of the five yellows-resistant varieties in comparison with the standard Golden Acre and Glory of Enkhuizen.

METHOD OF TESTING

The five resistant varieties have been under close observation during the last several years at Madison, Wis. These studies were begun in

1936 with Marion Market, Globe, Racine Market, and Resistant Detroit. Wisconsin Golden Acre was added to the list in 1938 (2 years before it was introduced). A representative strain of Golden Acre was used throughout as a standard for comparison. Glory of Enkhuizen was included in replicated trials in 1936 only.

Beginning in 1936, field trials were conducted in which 25-plant rows of each variety under test were planted in random order in three or four replicate plots. Seed was sown in the greenhouse in March, and plants were pricked to flats about 2 weeks later. The flats were moved to outdoor coldframes in early April. In mid-May the plants were transplanted to field plots, where they were set in rows 30 inches apart and spaced at 18 inches in the row. In some cases a late planting was made in mid-June from seed sown outdoors in early May. Unless otherwise indicated, overhead irrigation was provided when needed. The usual practices of cultivation and insect control were carried out.

As the various lots approached maturity, notes were taken on leaf and head characters. Color values were rated according to the standards of Maerz and Paul (5). When a given lot had reached peak harvest, that is, when 50 percent or more of the heads were hard and ready for harvest, 10 mature plants were selected at random and certain of their physical measurements were recorded. These measurements included plant height and width; number and weight of outer leaves; stem length (from surface of the soil to base of head); greatest equatorial and polar diameters, shape, and weight of head; and length of core. The data thus obtained were evaluated by the analysis-of-variance method.

COMPARISON OF VARIETAL CHARACTERS

DAYS FROM TRANSPLANTING TO MATURITY

The time required for a given strain of cabbage to mature varies widely with the environment. Therefore, any data on the period from transplanting to maturity of varieties can apply only to the district in which trials were made. In a single locality variations occur from season to season and with different dates of planting within a given season. In general, the number of days from transplanting to maturity was less in plantings made with plants grown in outdoor seedbeds from June 15 to July 1 than in those made with coldframe plants from May 10 to 25.

The most complete comparisons were made with the early plantings. The range in days from transplanting to the time when at least 50 percent of the heads of a variety were mature is given in table 1. It may be seen that considerable variation occurred from year to year, but throughout the trials the varieties remained in the same order as to maturity. Wisconsin Golden Acre was the earliest in the group to mature under these conditions. It was 2 to 7 days earlier than Golden Acre. Resistant Detroit was 0 to 7 days later than Golden Acre. Racine Market was 7 to 16 days later than Resistant Detroit. Marion Market was 3 to 10 days later than Racine Market. Glory of Enkhuizen was about the same in season as Marion Market. Globe was 0 to 6 days later than Marion Market.

TABLE 1.—*Time required for at least 50 percent of the heads of each of 7 varieties of cabbage in the early and midseason roundhead groups to mature when planted early at Madison, Wis.*

Variety	Time from transplanting to maturity in—									
	1936	1937	1938	1939	1940	1941	1942	1943	1944	
	Days	Days	Days	Days	Days	Days	Days	Days	Days	Days
Wisconsin Golden Acre			60	62	68	56	59	60	57	
Golden Acre	60		67	66	70	61		64	63	
Resistant Detroit	64	65	68	73	73	61	67	65	64	
Racine Market	71	75	84	82	82					
Marion Market	81	85	87		91		90	90		
Glory of Enkhuizen	81									
Globe	83		93		91					

It may be seen that the five yellows-resistant varieties supplemented one another as to season and that they covered a range of maturity from slightly less to slightly more than that in the susceptible varieties in these groups as represented by the early Golden Acre and the mid-season Glory of Enkhuizen.

LEAF AND PLANT CHARACTERS

The most important leaf characters are given for each variety in table 2. A representative mature plant of each, except Glory of Enkhuizen, is shown in figure 1. The chief differences between the respective varieties and Golden Acre are as follows. Wisconsin Golden Acre was very similar to Golden Acre, but they differed slightly in color and the tops of the outermost leaves of Golden Acre were more broadly rounded. Resistant Detroit differed still more in color, in the slightly smoother surface and margin of its leaves, and in the narrower wedging of the bases of some outer leaves. Racine Market was more distinct; the outer leaves were generally more erect; the leaf surface, margin, and edge were smoother; the bases of the outermost leaves tended to be more petiolate; the bloom was heavier; and the leaf blades were distinctly bluer. In Marion Market the outermost leaves drooped slightly; the innermost leaves enveloped the head loosely; the bloom was slightly heavier; and the color values were distinctly different. In Globe the middle leaves were more erect; the innermost leaves enveloped the head loosely; the outermost leaves were narrowly wedged at the base; the bloom was heavy; and the color values were distinctly different. In Glory of Enkhuizen the innermost leaves enveloped the head loosely; the surface tended to be more undulate and the edge more crenate; the bases of the outermost leaves were more narrowly wedged; the bloom was fairly heavy; and the color values were distinctly different.



GOLDEN ACRE



RACINE MARKET



WISCONSIN GOLDEN ACRE



MARION MARKET



RESISTANT DETROIT



GLOBE

FIGURE 1.—Representative mature plants of six varieties of cabbage in the early and midseason roundhead groups.

TABLE 2.—*Outer-leaf characters of 7 varieties of cabbage in the early and mid-season roundhead groups grown at Madison, Wis.*

[Color values according to Maerz and Paul (5)]

Variety	Shape of top	Shape of base of—		Ribs	
		Outermost leaves	Innermost leaves	Thickness and prominence	Color
Golden Acre.....	Broadly rounded.....	Wedged.....	Broadly wedged.	Medium thick and medium conspicuous color.	19 H 1.
Wisconsin Golden Acre.....	Rounded to broadly rounded.....	do.....	do.....	do.....	19 D 2.
Resistant Detroit.....	do.....	Narrowly wedged to wedged.	do.....	do.....	19 D 1.
Racine Market.....	Rounded.....	Petiolate to wedged.	Wedged to broadly wedged.	do.....	19 C 1 to 19 E 1.
Marion Market.....	Broadly rounded.....	Narrowly wedged to wedged.	Broadly wedged.	do.....	18 B 3 to 18 B 2.
Globe.....	Rounded to broadly rounded.....	Narrowly wedged.	Wedged to broadly wedged.	Medium thick; prominent.	17 B 3 to 17 B 2.
Glory of Enkhuizen.....	Broadly rounded.....	do.....	Broadly wedged.	do.....	18 C 3.

Variety	Veins			Bloom on blade	Blade color
	Thickness and prominence	Color			
Golden Acre.....	Medium thick and medium conspicuous.	19 D 2.....	Medium.....	.....	22 B 7 to 22 E 7.
Wisconsin Golden Acre.....	do.....	19 E 3.....	do.....	.....	22 B 3 to 22 B 5.
Resistant Detroit.....	do.....	19 F 2.....	do.....	.....	21 E 5 to 22 B 6.
Racine Market.....	do.....	19 G 2 to 19 B 5.	Fairly heavy.....	.....	22 C 6 to 22 C 5.
Marion Market.....	do.....	18 E 3 to 18 D 4.	Medium to fairly heavy.	.....	21 F 5.
Globe.....	Medium thick and conspicuous.	17 E 2 to 17 D 3.	Heavy.....	.....	28 C 3.
Glory of Enkhuizen.....	Medium thick and medium conspicuous.	18 C 3.....	Medium to fairly heavy.	.....	23 J 7.

Variety	Direction of—			.....	.....
	Outermost leaves	Middle leaves	Innermost leaves		
Golden Acre.....	Slightly above horizontal.	Curving up to 45° above horizontal.	Tip erect and slightly above and well away from head.	.....	.....
Wisconsin Golden Acre.....	Slightly above horizontal to horizontal.	do.....	do.....	.....	.....
Resistant Detroit.....	do.....	do.....	do.....	.....	.....
Racine Market.....	Slightly to 30° above horizontal.	Curving up broadly to nearly vertical.	Tip erect and well above and fairly close to head.	.....	.....
Marion Market.....	Horizontal to slightly drooping.	Entire leaf at about 45°.	Tip erect and slightly above head and enveloping it loosely.	.....	.....
Globe.....	Slightly above horizontal.	Curving up to 60° above horizontal.	do.....	.....	.....
Glory of Enkhuizen.....	do.....	Curving up to 45° above horizontal.	do.....	.....	.....

Variety	Curvature along and across midrib	Surface	Margin	Edge
Golden Acre.....	Curving up moderately.	Slightly undulate.....	Slightly undulate.....	Stightly crenate to crenate. Do.
Wisconsin Golden Acre.....	do.....	do.....	do.....	.....
Resistant Detroit.....	do.....	Nearly smooth to slightly undulate.	Nearly smooth to moderately undulate.	Slightly crenate.
Racine Market.....	Curving up decidedly.	Smooth to nearly smooth.	Smooth to nearly smooth.	Nearly smooth.
Marion Market.....	Curving up slightly.	Nearly smooth to slightly undulate.	Slightly undulate.	Slightly crenate to crenate.
Globe.....	Curving up slightly to moderately.	Smooth to slightly undulate.	Slightly to moderately undulate.	Slightly crenate.
Glory of Enkhuizen.....	Curving up slightly.	Slightly undulate to undulate.	do.....	Moderately crenate.

PLANT HEIGHT AND WIDTH

Measurements of plant height and width made in 1936, 1938, and 1940 on early-planted irrigated plots are given in table 3. Wisconsin Golden Acre, Golden Acre, Resistant Detroit, and Racine Market were not consistently distinct from one another, but the first-named was shortest in both years it was tested. Marion Market, Globe, and Glory of Enkhuizen did not differ consistently from one another in height and width. When compared with the first four varieties, however, the difference for each measurement was highly significant in each variety comparison.

TABLE 3.—*Average height and width of mature plants of 7 varieties of cabbage in the early and midseason roundhead groups when planted early and irrigated at Madison, Wis.*

Variety	Height in—			Width in—		
	1936 Centi- meters	1938 Centi- meters	1940 Centi- meters	1936 Centi- meters	1938 Centi- meters	1940 Centi- meters
Golden Acre	21.8	27.1	25.4	47.2	60.8	59.3
Wisconsin Golden Acre		26.1	22.6		61.3	55.1
Resistant Detroit	23.0	29.5	24.7	51.7	64.6	59.7
Racine Market	25.7	27.9	25.2	50.6	62.8	59.6
Marion Market	34.0	34.5	27.5	68.4	70.6	71.1
Globe	34.4	32.6	28.0	66.1	69.7	70.0
Glory of Enkhuizen	32.9			69.5		
Difference required for significance:						
5-percent level	1.6	1.9	1.7	3.0	2.4	4.7
1-percent level	2.1	2.6	2.3	4.0	3.3	6.3

NUMBER AND WEIGHT OF OUTER LEAVES

The average number of outer leaves per plant at harvest in early-planted, irrigated plots is shown in table 4. Racine Market had significantly fewer leaves than other varieties tested in four out of five seasons. Globe always had the largest number of outer leaves; in three out of four seasons the number was highly significantly larger.

The average total weights of outer leaves per plant are also given in table 4. The four early varieties were in all cases highly significantly lower in leaf weight than the three midseason varieties. There was not a close correlation between number and weight of leaves. Racine Market, for instance, although usually significantly lower in leaf number than any other variety, was lowest in leaf weight in only one season.

TABLE 4.—Average number of outer leaves at maturity and their total weight on 7 varieties of cabbage in the early and midseason round-head groups when planted early and irrigated at Madison, Wis.

Variety	Outer leaves in—				
	1936	1937	1938	1939	1940
	Number	Number	Number	Number	Number
Golden Acre	22.2	—	14.4	15.1	13.1
Wisconsin Golden Acre	—	—	15.4	16.3	14.2
Resistant Detroit	22.5	17.4	13.7	15.1	14.2
Racine Market	23.7	14.7	11.5	13.4	11.8
Marion Market	23.9	17.2	15.4	—	14.2
Globe	27.3	18.3	17.8	—	16.5
Glory of Enkhuizen	23.1	—	—	—	—
Difference required for significance:					
5-percent level	1.5	1.5	1.3	1.3	1.2
1-percent level	2.0	2.0	1.8	1.8	1.6

Variety	Weight of outer leaves in—				
	1936	1937	1938	1939	1940
	Grams	Grams	Grams	Grams	Grams
Golden Acre	577	—	758	469	579
Wisconsin Golden Acre	—	—	726	467	516
Resistant Detroit	614	872	812	562	733
Racine Market	694	748	773	476	657
Marion Market	1,311	1,566	1,257	—	1,115
Globe	1,449	1,562	1,304	—	1,405
Glory of Enkhuizen	1,360	—	—	—	—
Difference required for significance:					
5-percent level	110	167	108	52	170
1-percent level	147	226	146	73	229

LENGTH OF STEMS

Measurements of stem length made in 1936, 1938, and 1940 on early-planted irrigated plots are given in table 5. Wisconsin Golden Acre, Resistant Detroit, and Racine Market were usually very similar as to stem length. Golden Acre tended to be slightly longer stemmed but not always significantly so. The midseason varieties Marion Market, Globe, and Glory of Enkhuizen were rather close to one another, and as a group they were longer stemmed than the varieties in the early group. The differences between varieties of the two groups were usually significant.

TABLE 5.—*Average stem length of mature plants of 7 varieties of cabbage in the early and midseason roundhead groups when planted early and irrigated at Madison, Wis.*

Variety	1936	1938	1940
	Centime- ters	Centime- ters	Centime- ters
Golden Acre	9.4	7.7	7.0
Wisconsin Golden Acre		7.4	6.0
Resistant Detroit	8.5	7.6	6.5
Racine Market	8.6	6.8	6.6
Marion Market	9.7	10.1	8.3
Globe	11.1	9.3	7.8
Glory of Enkhuizen	11.1		
Difference required for significance:			
5-percent level	1.8	.8	.8
1-percent level	2.4	1.1	1.1

HEAD CHARACTERS

The head characters of the seven varieties differed relatively little except in size. A representative head of each variety except Glory of Enkhuizen is shown in figure 2. All were nearly spherical. Racine Market commonly had on the top of the head a roughly circular area about 1 inch in diameter which was raised about one-fourth inch above the remainder of the surface of the head; the outermost leaves of the head usually reached just past the center of the head and tended to recurve at the edge, and, although they lay rather close to the head, as a rule they were easily removed; the ribs were prominent but inconspicuous in color. The veins were very prominent in Globe but only moderately so in the other varieties. Color of the head was more yellowish in the order: First, Golden Acre; next, Wisconsin Golden Acre; then the three Resistant Detroit, Marion Market, and Glory of Enkhuizen (19 I 4 to 19 H 6); it was somewhat less yellow and more blue in Globe (19 F 3), and bluest in Racine Market (19 B 3).

The interior of a representative head of each variety except Glory of Enkhuizen is shown in figure 3. The heads were usually nearly circular in vertical cross section. Mature heads of all varieties were compact. The leaf laminae were characteristically uneven rather than flat; this feature gave a crumpled appearance to the leaves in a cross section of the head. The midribs arose from the core at slightly above horizontal and curved sharply upward. The core of Racine Market tended to be longer and narrower than those of other varieties, whereas the cores of Globe and Glory of Enkhuizen tended to be shorter.

EQUATORIAL AND POLAR DIAMETER OF HEADS

The equatorial and polar diameters of the heads in several seasons are given in table 6. Early-planted plots were irrigated each year except 1944, when the rainfall was adequate without supplementary watering. In 1940 four plots were set up containing each variety. Two of these were plots filled with coldframe plants set out in mid-May; one plot was irrigated and the other received only rainfall.



GOLDEN ACRE



RACINE MARKET



WISCONSIN GOLDEN ACRE



MARION MARKET



RESISTANT DETROIT



GLOBE

FIGURE 2.—Representative heads of six varieties of cabbage in the early and midseason roundhead groups.

The other two plots, filled with plants grown outdoors, were set out in mid-June; one was irrigated and the other received only rainfall.

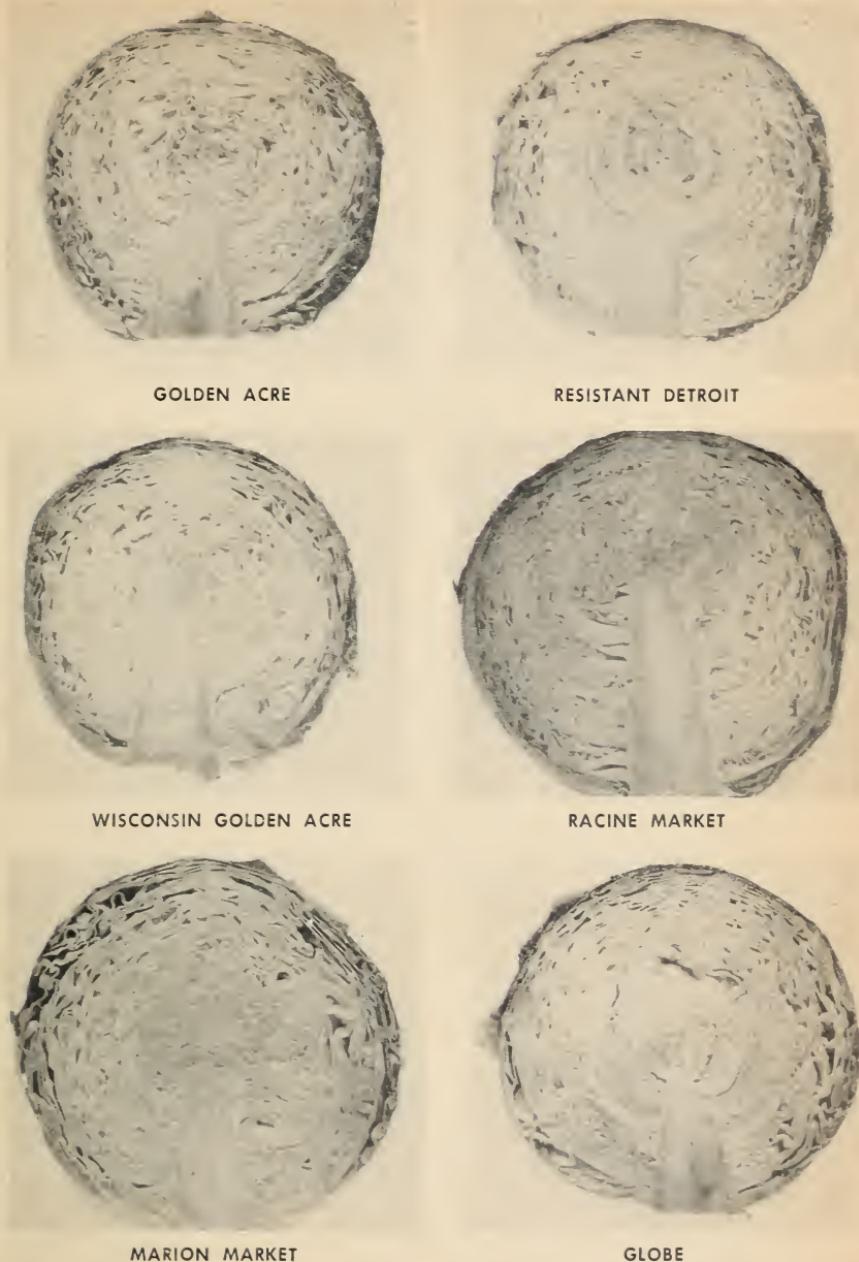


FIGURE 3.—Vertical cross sections of representative heads of six varieties of cabbage in the early and midseason roundhead groups.

The equatorial diameter of the heads of Wisconsin Golden Acre tended to measure less than that of Golden Acre heads. Resistant Detroit heads tended to be slightly greater in this measurement than those of Golden Acre, the difference being significant at the 5-percent level in four out of nine comparisons. Racine Market heads were sig-

nificantly greater in equatorial diameter in four out of seven comparisons. The equatorial diameter of Marion Market was highly significantly greater than that of Golden Acre in four out of six comparisons; that of Globe was highly significantly greater in five out of six comparisons and significantly so in the sixth comparison. That of Glory of Enkhuizen was highly significantly greater in the only test in which it was included.

TABLE 6.—*Average equatorial and polar diameters of mature heads of 7 varieties of cabbage in the early and midseason roundhead groups when grown at Madison, Wis.*

Variety	Equatorial diameter under indicated conditions				
	Early-planted, irrigated, 1936	Early-planted, irrigated, 1938	Early-planted, irrigated, 1939	Early-planted, irrigated, 1940	Early-planted, nonirrigated, 1940
Golden Acre-----	10.4	17.6	13.2	18.0	17.3
Wisconsin Golden Acre-----		17.6	12.9	16.2	16.1
Resistant Detroit-----	11.6	18.6	13.8	19.0	16.7
Racine Market-----	13.7	20.4	13.0	19.7	17.6
Marion Market-----	16.8	19.2	-----	19.1	16.9
Globe-----	16.0	18.9	-----	21.5	19.8
Glory of Enkhuizen-----	16.5	-----	-----	-----	-----
Difference required for significance:					
5-percent level-----	1.0	1.0	.7	1.5	.9
1-percent level-----	1.3	1.4	1.0	2.0	1.2

Equatorial diameter under indicated conditions—Con.

Variety	Late-planted, irrigated, 1940	Late-planted, nonirrigated, 1940	Early-planted, irrigated, 1941	Early-planted, nonirrigated, 1944
Golden Acre-----	16.4	15.5	15.2	15.8
Wisconsin Golden Acre-----	14.4	14.3	14.2	14.8
Resistant Detroit-----	15.9	16.8	15.2	17.0
Racine Market-----	17.0	17.9	-----	-----
Marion Market-----	19.5	19.9	-----	-----
Globe-----	20.2	21.9	-----	-----
Glory of Enkhuizen-----	-----	-----	-----	-----
Difference required for significance:				
5-percent level-----	1.8	1.0	.6	1.2
1-percent level-----	2.5	1.4	.8	1.8

TABLE 6.—Average equatorial and polar diameters of mature heads of 7 varieties of cabbage in the early and midseason roundhead groups when grown at Madison, Wis.—Continued

Variety	Polar diameter under indicated conditions				
	Early-planted, irrigated, 1936	Early-planted, irrigated, 1938	Early-planted, irrigated, 1939	Early-planted, irrigated, 1940	Early-planted, nonirrigated, 1940
	Centimeters	Centimeters	Centimeters	Centimeters	Centimeters
Golden Acre-----	11. 3	16. 6	14. 0	17. 9	17. 2
Wisconsin Golden Acre-----		16. 1	13. 8	16. 5	15. 9
Resistant Detroit-----	12. 2	17. 6	15. 7	17. 8	16. 2
Racine Market-----	14. 3	19. 7	15. 2	20. 0	18. 2
Marion Market-----	16. 8	19. 9	-----	19. 9	17. 4
Globe-----	15. 9	19. 2	-----	20. 7	18. 7
Glory of Enkhuizen-----	15. 5	-----	-----	-----	-----
Difference required for significance:					
5-percent level-----	. 8	. 6	1. 3	1. 2	. 8
1-percent level-----	1. 1	. 8	1. 8	1. 6	1. 1

Polar diameter under indicated conditions—Con.

Variety	Late-planted, irrigated, 1940	Late-planted, nonirrigated, 1940	Early-planted, irrigated, 1941	Early-planted, nonirrigated, 1944			
					Centimeters	Centimeters	
Golden Acre-----	16. 3	15. 2	15. 4	16. 5			
Wisconsin Golden Acre-----	14. 3	14. 3	14. 7	15. 1			
Resistant Detroit-----	15. 4	16. 3	16. 2	17. 1			
Racine Market-----	16. 5	17. 7	-----	-----			
Marion Market-----	18. 0	17. 2	-----	-----			
Globe-----	19. 1	21. 0	-----	-----			
Glory of Enkhuizen-----	-----	-----	-----	-----			
Difference required for significance:							
5-percent level-----	. 9	. 9	. 8	. 9			
1-percent level-----	1. 2	1. 2	1. 1	1. 4			

The polar diameters of heads followed the same trends as the equatorial diameters (table 6). There was, therefore, a fairly definite correlation between period from transplanting to maturity and size of head.

In 1940 nonirrigated plants produced smaller heads than irrigated ones in the early plantings, but irrigation made little difference in the

late plantings. The heads of the four early varieties, however, tended to be larger when they were planted early. These differences associated with planting conditions were less pronounced for midseason varieties like Marion Market and Globe. It is evident, therefore, that in this district the earlier varieties, particularly Wisconsin Golden Acre and Golden Acre, are best adapted to early planting when artificial watering provides continuously favorable moisture. The three later varieties, however, are adapted to both early and late planting and have less exacting moisture requirements.

SHAPE OF HEADS

The length-width ratios in table 7 indicate that all varieties tested had heads which were nearly spherical. Shape varied somewhat from season to season, and in 1940 the heads, as a rule, averaged slightly flatter in the late plantings than in the early ones. The greatest difference between plantings was in Marion Market. The influence of environmental factors on the length-width ratios in this variety was studied previously by Flory and Walker (3).

TABLE 7.—*Head shape of 7 varieties of cabbage in the early and mid-season roundhead groups when grown at Madison, Wis.*

[Length-width ratio obtained by dividing average polar diameter by average equatorial diameter; 1.00 indicates a perfectly spherical head; values above 1.00, oblongness; values below 1.00, flatness]

Variety	Length-width ratio under indicated conditions				
	Early-planted, irrigated, 1936	Early-planted, irrigated, 1938	Early-planted, irrigated, 1939	Early-planted, irrigated, 1940	Early-planted, nonirrigated, 1940
Golden Acre-----	1.09	0.94	1.06	0.99	0.99
Wisconsin Golden Acre-----		.91	1.07	1.02	.99
Resistant Detroit-----	1.05	.95	1.14	.94	.97
Racine Market-----	1.04	.97	1.17	1.02	1.03
Marion Market-----	1.00	1.04	-----	1.04	1.03
Globe-----	.99	1.02	-----	.96	.94
Glory of Enkhuizen-----	.94	-----	-----	-----	-----

Length-width ratio under indicated conditions—Con.

Variety	Late-planted, irrigated, 1940	Late-planted, nonirrigated, 1940	Early-planted, irrigated, 1941	Early-planted, nonirrigated, 1944
			-----	-----
Golden Acre-----	0.99	0.98	1.01	1.04
Wisconsin Golden Acre-----	.99	1.00	1.04	1.02
Resistant Detroit-----	.97	.97	1.07	1.01
Racine Market-----	.97	.99	-----	-----
Marion Market-----	.92	.86	-----	-----
Globe-----	.95	.96	-----	-----
Glory of Enkhuizen-----	-----	-----	-----	-----

LENGTH OF CORES

The core length in any given variety in any given season is best evaluated in relation to the polar diameter. In table 8 are given the average core lengths and the ratios obtained by dividing the average polar diameter by the average core length. Here it may be seen that the ratio for Racine Market was lowest and the core length thus relatively the greatest in four out of seven comparisons. For Globe this ratio in any given set of comparisons was the highest in the group except in the late nonirrigated plantings of 1940. It may be stated, therefore, that Racine Market tends to contain longer average cores than the other varieties and Globe shorter average cores. It is obvious that growing conditions cause considerable variability in this ratio, and the values were less constant in the group as a whole than the ratios of polar diameter to equatorial diameter.

WEIGHT OF HEADS

The average weights of mature heads in several seasons are given in table 9. As already indicated by diameter measurements, heads of Wisconsin Golden Acre usually weighed less than those of Golden Acre; the difference was significant in four out of eight comparisons. Resistant Detroit heads were usually heavier than those of Golden Acre; however, the differences were significant in only two out of nine comparisons, while in one comparison Resistant Detroit was significantly lighter. Racine Market was heavier than Golden Acre in five out of seven comparisons; the difference was highly significant in only two cases and significant in one other case. Marion Market was heavier than Golden Acre in six out of seven comparisons; the difference was highly significant in each case. Globe was heavier than Golden Acre in each of the six comparisons; the difference was highly significant in each case.

In general head weight increased with length of the period from transplanting to maturity. This might well be expected if uniform growing conditions prevailed. Periods of unfavorable weather might affect varieties differently. In 1940 all varieties yielded best when planted early and irrigated. When early- and late-planted non-irrigated plots are compared, it is evident that Golden Acre and Wisconsin Golden Acre were suppressed decidedly in yield by late planting, that Resistant Detroit and Racine Market were reduced less, and that Marion Market and Globe yielded more heavily in the late plantings than in the early ones. General observations of the varieties over a 10-year period have shown that Wisconsin Golden Acre and Golden Acre are best adapted to early planting in Wisconsin, for in late plantings they tend to mature more rapidly but produce small heads. Marion Market and Globe, on the other hand, are admirably suited to late planting for maturity in September; but they also do well in early plantings. Resistant Detroit and Racine Market are suited to both early and late planting, but they may be expected to yield somewhat better in earlier plantings. An outstanding feature of Racine Market is that the heads harden slowly and are much less prone to burst than the other varieties in the early group. This long-standing character is a valuable one, since it permits a longer period for harvest and marketing, which is particularly important in a variety coming to maturity in midsummer.

SUMMARY OF VARIETAL CHARACTERS

The five yellows-resistant varieties of cabbage in the early and mid-season roundhead groups (Wisconsin Golden Acre, Resistant Detroit, Racine Market, Marion Market, and Globe) supplement one another in time of maturity and extend it from one slightly earlier than that

TABLE 8.—*Average lengths of cores and ratios of polar diameters to core lengths of 7 varieties of cabbage in the early and midseason roundhead groups when grown at Madison, Wis.*

Variety	Average length of core under indicated conditions				
	Early-planted, irrigated, 1936	Early-planted, irrigated, 1938	Early-planted, irrigated, 1939	Early-planted, irrigated, 1940	Early-planted, nonirrigated, 1940
Golden Acre	4.7	8.6	7.6	10.5	8.8
Wisconsin Golden Acre		8.5	6.7	9.5	9.0
Resistant Detroit	5.3	10.1	8.8	10.8	9.7
Racine Market	6.2	13.9	10.2	14.4	13.3
Marion Market	6.8	12.4		14.5	10.3
Globe	5.7	8.7		8.5	8.0
Glory of Enkhuizen	5.9				
Difference required for significance:					
5-percent level	.5	1.3	.9	2.0	1.1
1-percent level	.7	1.7	1.3	2.7	1.5

Variety	Average length of core under indicated conditions—Con.			
	Late-planted, irrigated, 1940	Late-planted, nonirrigated, 1940	Early-planted, irrigated, 1941	Early-planted, nonirrigated, 1944
Golden Acre	9.0	8.1	7.8	10.2
Wisconsin Golden Acre	8.0	6.5	8.1	9.2
Resistant Detroit	9.3	8.6	8.2	10.9
Racine Market	10.5	10.9		
Marion Market	11.3	10.8		
Globe	10.1	10.2		
Glory of Enkhuizen				
Difference required for significance:				
5-percent level	.9	1.0	1.2	1.5
1-percent level	1.2	1.4	1.8	2.2

TABLE 8.—*Average lengths of cores and ratios of polar diameters to core lengths of 7 varieties of cabbage in the early and midseason roundhead groups when grown at Madison, Wis.*—Continued

Variety	Ratio of polar diameter to core length under indicated conditions				
	Early-planted, irrigated, 1936	Early-planted, irrigated, 1938	Early-planted, irrigated, 1939	Early-planted, irrigated, 1940	Early-planted, nonirrigated, 1940
Golden Acre	2.40	1.93	1.84	1.70	1.95
Wisconsin Golden Acre		1.89	2.06	1.74	1.77
Resistant Detroit	2.30	1.74	1.78	1.65	1.67
Racine Market	2.31	1.42	1.49	1.39	1.37
Marion Market	2.47	1.60	—	1.37	1.69
Globe	2.79	2.21	—	2.44	2.34
Glory of Enkhuizen	2.63	—	—	—	—

Ratio of polar diameter to core length under indicated conditions—Con.

Variety	Ratio of polar diameter to core length under indicated conditions			
	Late-planted, irrigated, 1940	Late-planted, nonirrigated, 1940	Early-planted, irrigated, 1941	Early-planted, nonirrigated, 1944
Golden Acre	1.81	1.88	1.97	1.62
Wisconsin Golden Acre	1.79	2.20	1.81	1.64
Resistant Detroit	1.66	1.90	1.98	1.57
Racine Market	1.57	1.62	—	—
Marion Market	1.59	1.59	—	—
Globe	1.89	2.06	—	—
Glory of Enkhuizen	—	—	—	—

of the nonresistant Golden Acre to slightly later than that of the nonresistant Glory of Enkhuizen. The physical measurements for these varieties when grown at Madison, Wis., from 1936 to 1944 are summarized in table 10. The leaves of the different varieties are compared in table 2.

SALIENT DIFFERENCES BETWEEN GOLDEN ACRE AND GLORY OF ENKHUIZEN AND YELLOW-RESISTANT VARIETIES IN THE SAME GROUPS

Golden Acre is a nonresistant, short-season variety of cabbage, especially valuable for early-spring planting in the Northern States. It is also used in the lower Southern States, where low temperatures are

TABLE 9.—*Average weights of mature heads of 7 varieties of cabbage in the early and midseason roundhead groups when grown at Madison, Wis.*

Variety	Average head weight under indicated conditions					
	Early-planted, irrigated, 1936	Early-planted, irrigated, 1937	Early-planted, irrigated, 1938	Early-planted, irrigated, 1939	Early-planted, irrigated, 1940	Early-planted, nonirrigated, 1940
Golden Acre	Grams 552	Grams -----	Grams 1,783	Grams 1,072	Grams 2,066	Grams 2,050
Wisconsin Golden Acre			1,845	889	1,673	1,660
Resistant Detroit	711	1,844	2,209	1,225	2,378	1,673
Racine Market	1,035	2,378	2,916	1,146	2,487	1,914
Marion Market	1,766	3,162	3,033	1,309	2,863	1,830
Globe	1,531	3,060	2,823	-----	3,340	2,548
Glory of Enkhuizen	1,652	-----	-----	-----	-----	-----
Difference required for significance:						
5-percent level	172	372	255	147	391	297
1-percent level	228	503	345	215	548	416

Average head weight under indicated conditions—Con.

Variety	Late-planted, irrigated, 1940	Late-planted, nonirrigated, 1940	Early-planted, irrigated, 1941	Early-planted, nonirrigated, 1942	Early-planted, nonirrigated, 1944
	Grams	Grams	Grams	Grams	Grams
Golden Acre	1,377	1,383	1,679	-----	1,485
Wisconsin Golden Acre	1,092	987	1,309	1,706	1,397
Resistant Detroit	1,401	1,490	1,705	2,253	1,654
Racine Market	1,375	1,627	-----	2,234	-----
Marion Market	2,366	2,166	-----	3,555	-----
Globe	2,240	2,862	-----	-----	-----
Glory of Enkhuizen	-----	-----	-----	-----	-----
Difference required for significance:					
5-percent level	547	446	166	340	309
1-percent level	748	607	237	494	(1)

¹ Difference not significant.

infrequent (1). Wisconsin Golden Acre, Resistant Detroit, Racine Market, Marion Market, and Globe all differ from Golden Acre in being highly resistant to yellows.

Wisconsin Golden Acre differs also in maturing 2 to 7 days earlier and in having smaller plants and heads. Resistant Detroit differs from Golden Acre in being 0 to 7 days later and slightly larger in plant and head size. Racine Market differs in being 11 to 17 days later than

TABLE 10.—Summary of physical measurements of 7 varieties of cabbage in the early and midseason roundhead groups when grown at Madison, Wis.

Variety	Period from transplanting to maturity	Average plant height	Average plant width	Outer leaves		Average total weight	Grams
				Average number	Grams		
Wisconsin Golden Acre	56-68	22.6-26.1	55.1-61.3	14.2-16.3	467-	726	
Golden Acre	60-70	21.8-27.1	47.2-60.8	13.1-22.2	469-	758	
Resistant Detroit	61-73	23.0-29.5	51.7-64.6	13.7-22.5	562-	872	
Racine Market	71-84	25.2-27.9	50.6-62.8	11.5-23.7	476-	773	
Marion Market	81-91	27.5-34.5	68.4-71.1	14.2-23.9	1,115-	1,566	
Glory of Enkhuizen	81-88	28.0-32.9	69.5	23.1	1,	360	
Globe	83-93	28.0-34.4	66.1-70.0	16.5-27.3	1,301-	1,562	
Variety	Average stem length	Average diameter of head		Polar diameter ÷ equatorial diameter	Polar diameter ÷ core length	Average head weight	Grams
		Equatorial	Polar				
Wisconsin Golden Acre	6.0-7.4	12.9-17.6	Centimeters	Centimeters	Centimeters	1,64-2.20	889-1,845
Golden Acre	7.0-9.4	10.4-18.0				1.62-2.40	552-2.066
Resistant Detroit	6.5-8.5	11.6-19.0				1.57-2.30	711-2,378
Racine Market	6.6-8.6	13.0-20.4				1.37-2.31	1,035-2,916
Marion Market	8.3-10.1	16.8-19.9				1.37-2.47	1,301-3,555
Glory of Enkhuizen	11.1	16.5				1.89-2.63	1,652
Globe	7.8-11.1	16.0-21.9				1.89-2.79	1,531-3,340

Golden Acre, in being larger in plant and head size, in having smoother foliage, and in being bluer. Marion Market differs in being about 3 weeks later than Golden Acre, in being larger in plant height and width, and in having heavier and larger heads.

Glory of Enkhuizen, which has been described in detail by Boswell et al. (2), is rather close to Marion Market in season and in most plant characters. It is thus much later and larger than Golden Acre. Its chief difference from Marion Market is that it is very susceptible to yellows. Therefore, where a yellows-resistant variety is needed Marion Market can be substituted for Glory of Enkhuizen. Globe, a selection of Glory of Enkhuizen, is used in northern regions interchangeably with Marion Market. It is not used, however, so widely for winter growing in southern regions. Globe differs from Marion Market chiefly in being slightly later in reaching maturity and slightly bluer. Also, it tends to be somewhat more tolerant to cabbage mosaic (4), which is an important factor in cabbage-growing sections of the upper Mississippi Valley.

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